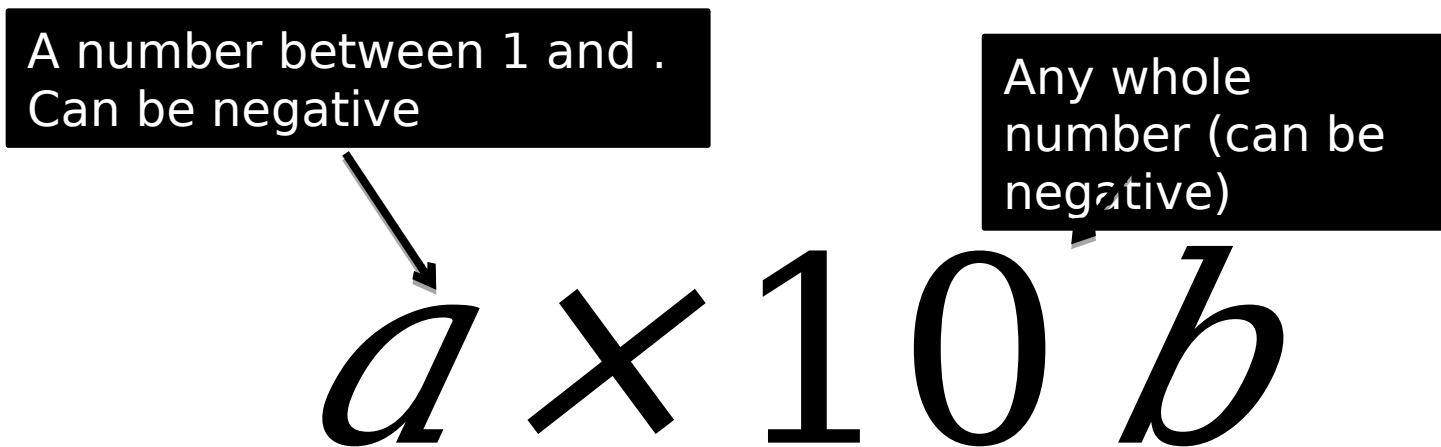


What is standard form?

A number between 1 and .
Can be negative

Any whole
number (can be
negative)



The diagram shows the standard form notation $a \times 10^b$. A callout box points to the a with the text "A number between 1 and . Can be negative". Another callout box points to the b with the text "Any whole number (can be negative)".

$$a \times 10^b$$

e.g. (we'll practise converting numbers to and from standard form in a moment...)

The “” bit tells us the ‘scale’ of the number, i.e. **how many place values left or right of the units digit**, the first digit of the number is.

The “3” bit gives us the digits actually used (excluding leading or trailing zeroes).

Why use standard form?

- a It allows us to write really small or really big numbers concisely.
- b It allows us to easily compare small and big numbers.

Which is

bigger?

2340000000000000000000

```

r3 23400000000000
00

```

1

Which is

4 bigger?

$$2.34 \times 10^{14}$$
$$2.34 \times 10^{13}$$

1

Ordering numbers in standard form

Put the following in ascending order of value:

$$3 \times 10^7$$

$$3 \times 10^9$$

$$2 \times 10^8$$

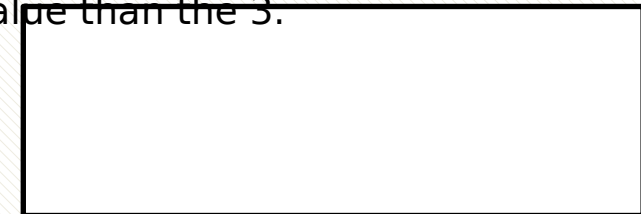
$$4 \times 10^7$$



Check the power first, because this gives a notion of how many digits the number has.



Although the 2 is smaller than 3, the power is greater, which always 'wins'. This tells us the 2 has a greater place value than the 3.



Test Your Understanding So Far

1

Country	Population
China	1.4×10^9
India	1.3×10^9
USA	3.2×10^8
Ethiopia	9.7×10^7
Mexico	1.2×10^8

Which country has

(a) The smallest

?

Ethiopia

(b) The largest
population?

China

2

Which of the following numbers are in standard form?

**as 1.1 is between 1 and 10.
The base of the power must be 10.**

?

Converting to Standard Form

Convert 4000 to standard form.

$$\boxed{?} \times 10^{\boxed{?}} = 4000.$$

...but now here

Decimal point was originally here (at end of number)

Step 1: For the first number, keep dividing/multiplying by 10 until you get a number between 1 and

Step 2: For the power of 10, count how many times the decimal place moved leftwards.

Convert 3 800 000 to standard form.

$\boxed{?}$

Test Your Understanding So Far

Convert 700 000 to standard form

?

Convert 267 800 000 to standard form.

?

Converting **small numbers** to Standard Form

Convert 0.002 to standard form.

$$\boxed{?} \times 10^{\boxed{?}}$$

Recall that the index here is the number of places the decimal place moved left. But we moved **right** 3 places, so it's negative!
Note that, using laws of indices,

, which is indeed 0.002.

Fro Tip 1: Remember that positive indices give big numbers, while negative indices give small numbers.

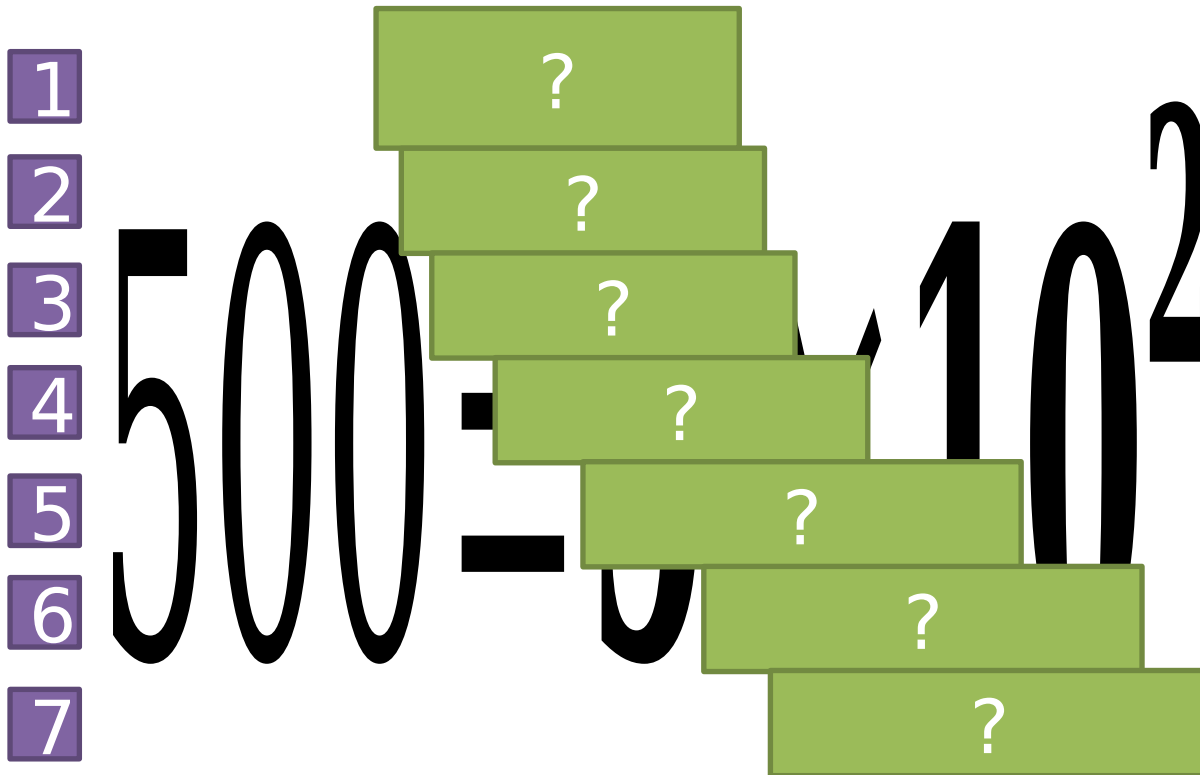
Fro Tip 2: When the index is negative, **just count the number of leading zeroes**.

Convert 0.000 00723 to standard form.

$$\boxed{?} \times 10^6$$

Quickfire Questions

Your teacher will target various people to answer, working them out **mentally in your head**.



Exercise 1

1 Express the following in

a standard form:

b

c

d Express the following in

e standard form:

f 5 million

g 2 thousand

h 8 billion

i

Express the following in standard form:

a

b

c

3

a

b

c

d

e

f

g

Pro Tip: It's helpful to remember that "thousand" is 10^3 and "million" is 10^6 . If for example we had 30 000 000, we'd instantly know it's as we've gone one extra digit beyond the million point.

4

Express the following in standard form:

a

b

c

d

e

f

g

h

[Edexcel] second is 0.000 000 001

second. Write 0.000 000 001 in standard form

5

Light travels approximately 300,000,000 metres each second. A light year is the total distance travelled by light in one year. Assuming there are 365 days in a year, determine a light year, answer in Standard Form (in metres).

6

The radius of the Earth is 6378.1km.

(a) What is the circumference of the Earth in metres, in standard form?

7

(b) How many times can light fully encircle the Earth per second? **7.49**

A 'bit' is the smallest unit of space in computing (holding a '0' or '1' value). There are 8 bits in a byte, 1000 bytes in a kilobyte, 1000 kilobytes in a megabyte, 1000 megabytes in a gigabyte, 1000 gigabytes in a terabyte, 1000 terabytes in a petabyte, 1000 petabytes in an exabyte and 1000 exabytes in a zettabyte. The size of the internet is approximately 8 zettabytes. How many bits are there on the internet (in Standard Form)?

Converting numbers from standard form

The reverse process, converting numbers from standard form back into 'normal numbers', is the same.

$$9 \times 10^4 = 9 \boxed{?}$$

$$7.31 \times 10^5 = 7.31 \boxed{?}$$

$$8.7 \times 10^{-3} = 8.7 \boxed{?}$$

$$2.65 \times 10^{-7} = 2.65 \boxed{?}$$

1. Recall that the index of the 10 tells us how many times we're multiply by 10 (or if negative, dividing by 10). Therefore count the number of decimal place jumps, **adding 0's if necessary**.
2. Remember that we use negative powers for small numbers, positive powers for large.

Recall the trick: For negative powers, the power matches the number of leading 0's.

Test Your Understanding

$$8.8 \times 10^7 = 8$$

?

$$6 \times 10^{-4} = 0$$

?

Exercise 2

Convert the following numbers from standard form to normal numbers.

1

a
b
c
d
e

$$7 \times 10^4 = \begin{array}{c} \boxed{?} \\ \boxed{?} \\ \boxed{?} \\ \boxed{?} \\ \boxed{?} \end{array}$$

2

a
b
c
d
e

$$2 \times 10^3 = \begin{array}{c} \boxed{?} \\ \boxed{?} \\ \boxed{?} \\ \boxed{?} \end{array}$$

3

a
b
c
d
e
f
g

$$6 \times 10^5 = \begin{array}{c} \boxed{?} \\ \boxed{?} \\ \boxed{?} \\ \boxed{?} \\ \boxed{?} \\ \boxed{?} \end{array}$$

Multiplying Numbers in Standard Form

$$(3 \times 10^7) \times (2 \times 10^4)$$

A diagram illustrating the multiplication of numbers in standard form. It shows the expression $3 \times 10^7 \times 2 \times 10^4$. The coefficient '3' is highlighted in red. The coefficient '2' is partially visible. The index '7' is partially visible. Two green boxes are placed over the expression: one box contains a question mark '?' and is positioned over the coefficient '2', and the other box contains a question mark '?' and is positioned over the index '4'. An arrow points from the first text box to the first green box, and another arrow points from the second text box to the second green box.

All the four things are being multiplied, and we can multiply in any order.
Firstly, what is the ?

And (thinking about laws of indices), what is ?

Multiplying Numbers in Standard Form

$$(7 \times 10^3) \times (6 \times 10^{10})$$

$? 4$ $?$

$? 4$ $?$

But this is NOT in standard form, as 42 is not between 1 and ...

...so we turn 42 into 4.2 by making it 10 times smaller.

To compensate, we make ten times bigger, by increasing the power by 1.

Further Examples


$$(3.5 \times 10^7) \times (4 \times 10^{-12})$$

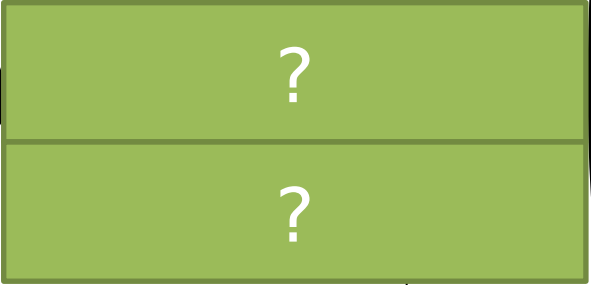
$$\begin{array}{|c|} \hline ? \\ \hline ? \\ \hline \end{array} \times 10^{-4}$$

Be careful with the negative ones. $-5 + 1 = -4$

$$(8 \times 10^{-6}) \times (7 \times 10^2)$$

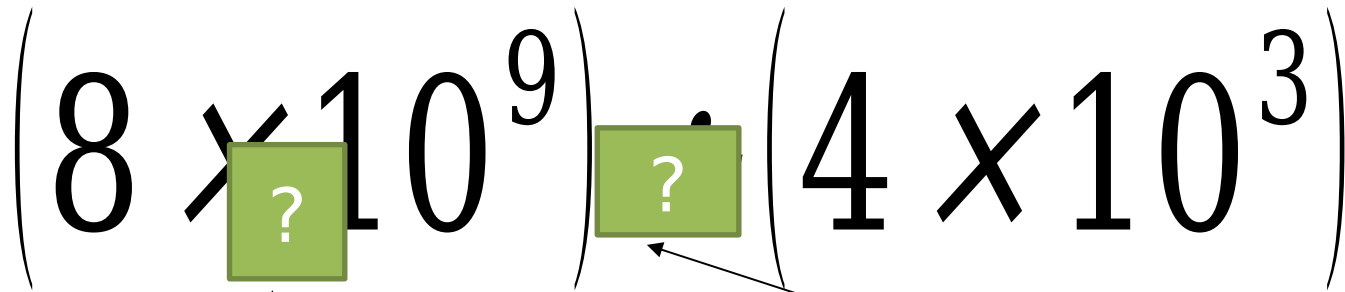
Test Your Understanding So Far

$$(2 \times 10^2) \times (4 \times 10^7)$$


$$(9 \times 10^{-5}) \times (7 \times 10^8)$$


Dividing Numbers in Standard Form

The process is pretty much the same for dividing numbers in standard form:

$$\left(8 \times \boxed{?} 10^9 \right) \div \left(4 \times 10^3 \right)$$


Firstly, what is ?

And (thinking about laws of indices), what is ?

Further Examples

$$(2 \times 10^8) \div (4 \times 10^3)$$

$$\begin{array}{r} 0.5 \\ 5 \end{array} \begin{array}{|c|} \hline ? \\ \hline ? \\ \hline \end{array}$$

This is the same principle as before but the opposite. 0.5 is too small so we to get it between 1 and . So **to compensate**, we have to make ten times smaller.

$$\left(2 \times 10^6 \right) \div \left(3 \times 10^{-4} \right)$$

$$\begin{array}{|c|} \hline ? \\ \hline ? \\ \hline \end{array}$$

Test Your Understanding

$$(6 \times 10^{14}) \div (3 \times 10^5)$$

?

2

?

$$(3 \times 10^2) \times (6 \times 10^7)$$

?

?

and on your calculator

Use the $\times 10^x$ button on your calculator to make calculations involving standard form. While you can explicitly write using the “ ” button, it’s faster to use the specialised standard form key.

$$(2.41 \times 10^{19}) \times (7.1 \times 10^{23}) = \boxed{?}$$

Exercise 3

1 a 1×10^4 b 5×10^9 c 10^4 d 10^9 e 10^4 f 10^9 g 10^4

3 [Edexcel GCSE June2007-4I Q23b, June2007-6H Q13b] In 2003 the population of Great Britain was In 2003 the population of India was In 1933 the population of Great Britain was

Calculate the percentage increase in the population of Great Britain from 1933 to 2003. Give your answer correct to one decimal place.

? .3%

2 a 5×10^7 b 1×10^2 c 10^7 d 10^2 e 10^7 f 10^2 g 10^7

4 [Edexcel IGCSE June2011-3H Q20] where is an integer and Find, in standard form, an expression for .

Give your expression as simply as

?

Adding and Subtracting

$$1000 + 2000 = \boxed{?}0$$

If the powers of 10 are the same, we can effectively 'collect like terms'.

Therefore:

$$(1 \times 10^3) + (2 \times 10^3) = \boxed{?} \times 10^3$$

If the powers are not the same, either:

- (a) Convert both numbers to normal numbers first, then add/subtract, then convert back to standard form.
- (b) Or better, change the number with the smaller power of 10 so it matches the power of the larger one.

$$\left(4 \times 10^3 \right) + \left(2 \times 10^4 \right) = \boxed{?} \times 10^{\boxed{?}}$$

Using strategy (b), we want to turn the 4×10^3 into the larger power of 10^4 . Since this is getting 10 times bigger, we have to make 4 ten times smaller **to compensate**.

Further Examples

$$\left(\begin{array}{cc|cc} 5 & 1 & 4 & 7 \\ \hline & & ? & \\ \hline & & ? & \end{array} \right) \quad \left(\begin{array}{cc|cc} 4 & 1 & 4 & 6 \\ \hline & & ? & \\ \hline & & ? & \end{array} \right)$$

$$\left(\begin{array}{cc|cc} 7 & 1 & 6 & \\ \hline & & ? & \\ \hline & & ? & \end{array} \right) \quad \left(\begin{array}{cc|cc} 6 & 1 & 6 & 8 \\ \hline & & ? & \\ \hline & & ? & \end{array} \right)$$

Exercise 4

1 $(1.1 \times 10^5) + (2 \times 10^4) = 1$? 10^5

2 $(.1 \times 10^5) - (2 \times 10^4) =$? 10^4

3 $(5 \times 10^7) + (2 \times 10^5) = 5$? 10^7

4 $(5.2 \times 10^{-2}) + (3 \times 10^{-3}) =$? 10^{-2}

5 $(\times 10^{10}) + (2 \times 10^{12}) = 2$? 10^{12}

6 $(.2 \times 10^{-4}) - (5 \times 10^{-5}) =$? 10^{-4}